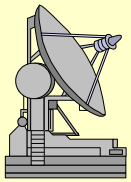


MODULE 1

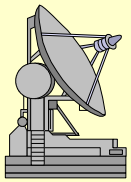
STT SYSTEMS ORIENTATION

1.1

Satellite Fundamentals

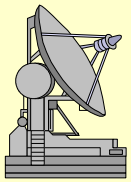
1.2

STT System Introduction



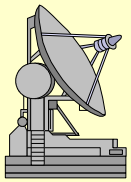
LESSON 1.1

SATELLITE FUNDAMENTALS



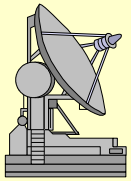
LESSON 1.1 OVERVIEW

- This lesson topic will cover:
  - Environmental Satellite Facts
  - Geostationary Satellites
  - Polar Orbiting Satellites
    - » DMSP Satellites
    - » NOAA Satellites
    - » Other Satellites
  - Satellite to Data Stream Correlation



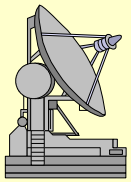
LESSON 1.1 OBJECTIVES

- T.O. 1.1: Using system manuals, precursor material and class notes, student will be able to demonstrate knowledge of:
  - Capabilities of the geostationary satellites.
  - Inclination angles, orbital periods, and site station circles.
  - Capabilities of DMSP and NOAA polar orbiting satellites.
  - Satellite to data stream correlation.



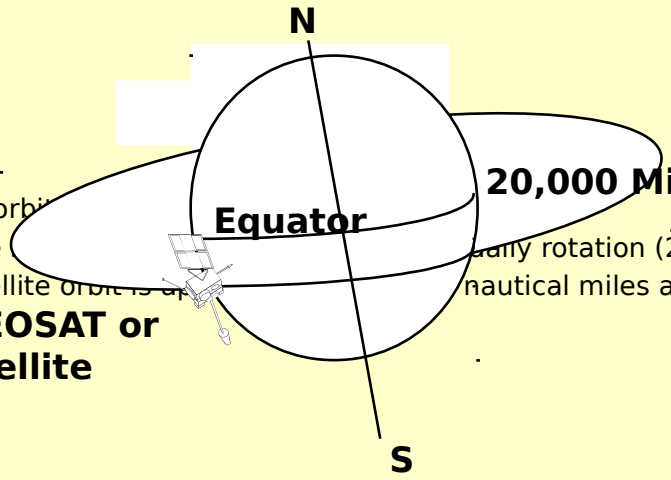
ENVIRONMENTAL SATELLITE FACTS

- There are two types of weather satellites: Geostationary and Polar-orbiting.
- In the US., non-DOD environmental satellite operations are the responsibility of the National Oceanic and Atmospheric Administration (NOAA).
- The Defense Meteorological Satellite Program (DMSP) operates polar-orbiting satellites to provide meteorological and environmental data to all branches of the military.
- Primary strategic users are:
  - » Air Force Global Weather Center (AFGWC)
  - » Navy Fleet Numerical Meteorology and Oceanography Center (FNMOC)
  - Primary tactical users are:
    - » Mark IV Mobile Terminals
    - » Mark IVB Fixed Terminals
    - » Small Tactical Terminals (STTs)
    - » Shipboard Receiving Terminals



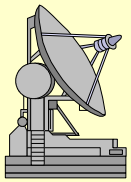
GEOSTATIONARY SATELLITES (pt 1 of 3)

- Geostationary weather satellites circle the Earth in a ***Geosynchronous*** orbit.



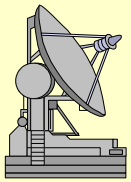
  - Geosynchronous means that the orbi
  - The orbital period is 24 hours, the daily rotation (23.9345).
  - The plane of a Geostationary satellite orbit is a nautical miles above the equator.

GOES, METEOSAT or GMS satellite



GEOSTATIONARY SATELLITES (pt 2 of 3)

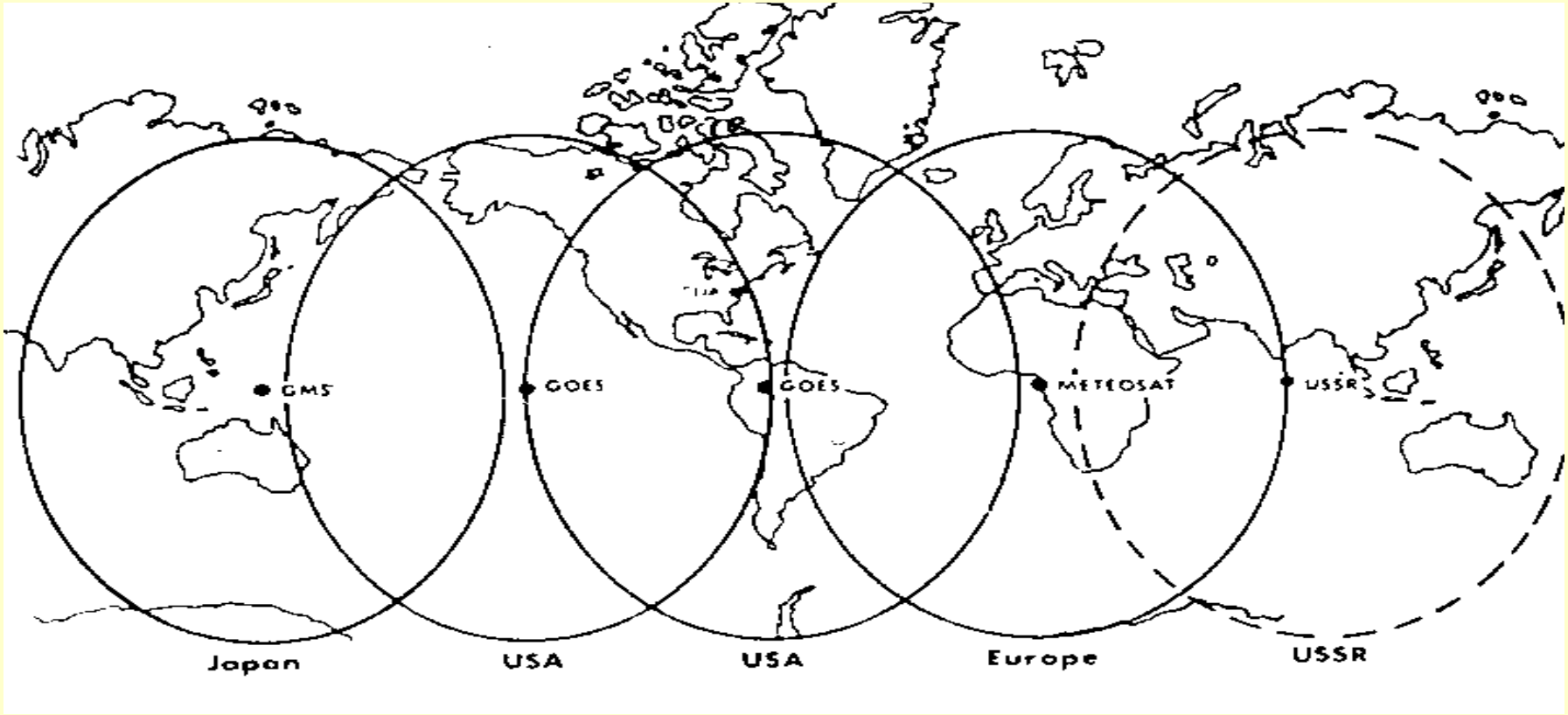
- Each satellite can obtain a full-disc view of Earth and provide observations every 30 minutes or less.
- The geostationary satellites send raw instrument sensor data streams to national ground stations for processing. The processed data stream is then transmitted back to the satellite for rebroadcast to the weather system users.
- The transmission of processed weather data (visible and infrared) by Geostationary satellites is called weather facsimile or WEFAX data.
  - Other meteorological products, such as upper air charts, are also transmitted as WEFAX data.

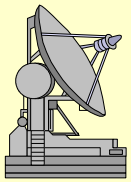


GEOSTATIONARY SATELLITES (pt 3 of 3)

- The US operates two satellites in geostationary orbit over the equator. They are referred to as (GOES):
  - GOES East (8) monitors most of North America and all of South America and the Atlantic Ocean region. Stationed over 75 degrees W.
  - GOES West (9) monitors the rest of North America and the Pacific Ocean region. Stationed over 135 degrees W.
- GMS/METEOSAT/GOMS
  - Geostationary Meteorological Satellite (GMS) is the Japanese geostationary satellite. Stationed over 140 degrees E.
  - METEOSAT is the European Space Agency's geostationary satellite. Stationed over 0 degrees Longitude.
  - Geostationary Operational Meteorological Satellite (GOMS) is the Russian Federation's geo satellite. Stationed over 76 degrees E.

WORLD GEOSTATIONARY COVERAGE





GEOSTATIONARY/WEFAX PROS AND CONS

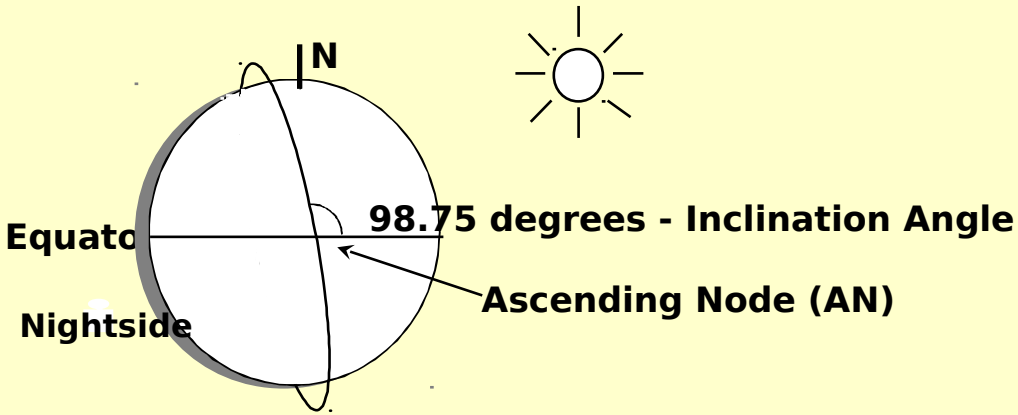
- **Pros**
  - Always in the same location.
  - Allows animation/ looping.

- **Cons**
  - Lower resolution for WEFAX images.
  - Images become distorted toward higher latitudes.
  - Schedule dictates which images you receive. For example: You may only receive two water vapor images per day.

POLAR-ORBITING SATELLITES

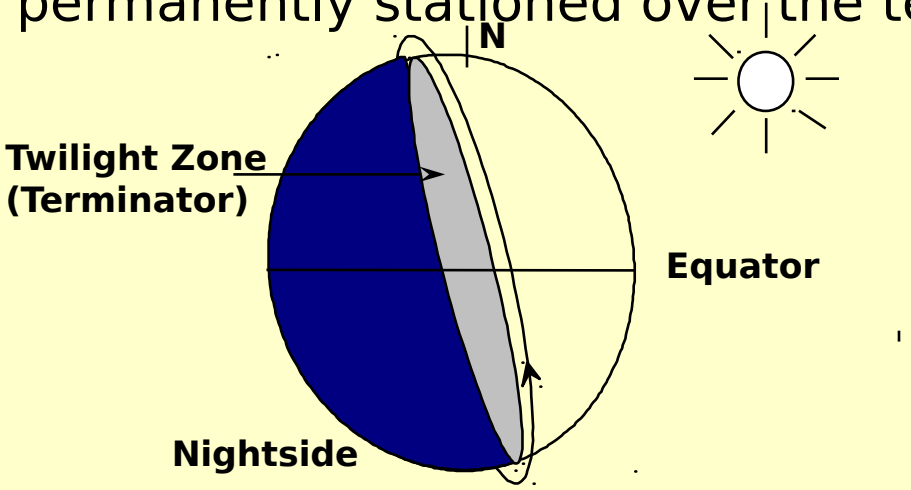
- The polar-orbiting satellites circle the Earth in a *sun-synchronous* polar orbit.
  - Sun-synchronous orbit means that the plane retains the same relative angle with respect to the sun as the earth revolves about the sun.

  - The ascending node (AN) is the point in the orbit at which the satellite crosses the equator from south to north.
  - The descending node (DN) is the point in the orbit at which the satellite crosses the equator from north to south.

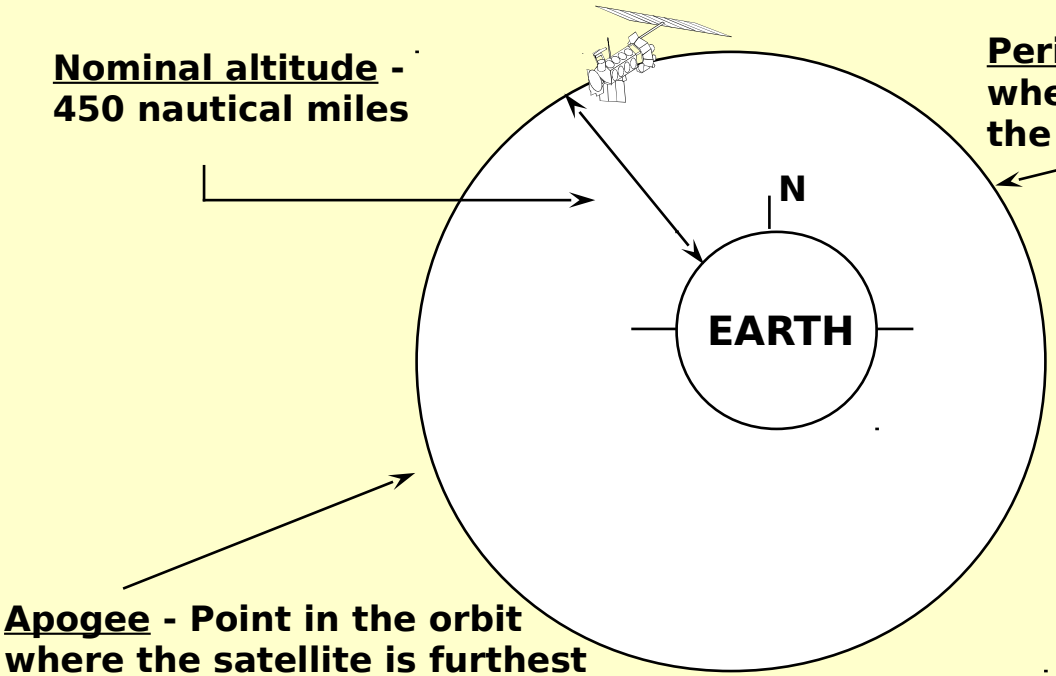


POLAR-ORBITER INCLINATION ANGLE

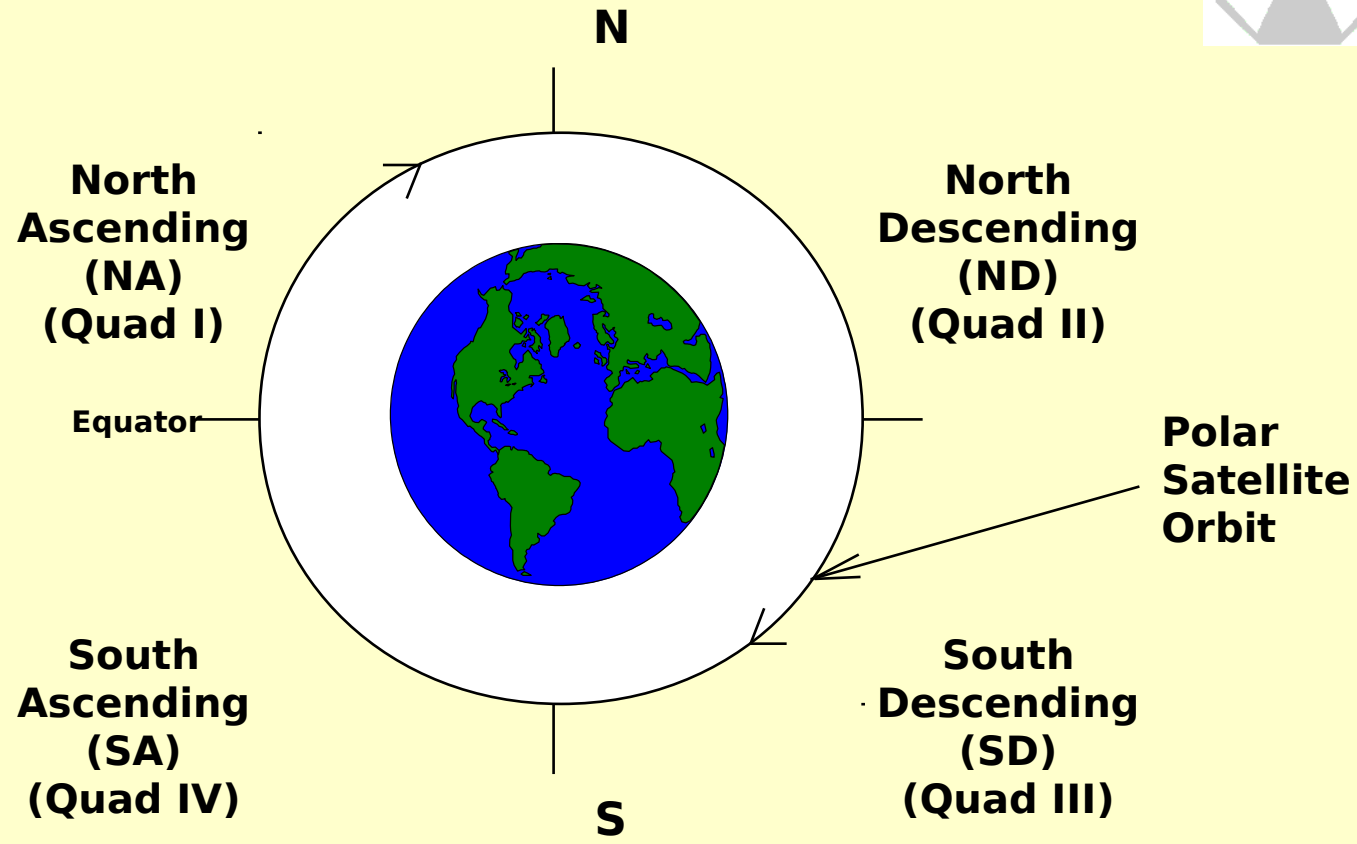
- Inclination angle:
  - Approximately 98 degrees for DMSP and NOAA satellites
  - For the morning DMSP satellite, this angle keeps the satellite permanently stationed over the terminator



POLAR ORBITAL PARAMETERS (pt 1 of 2)



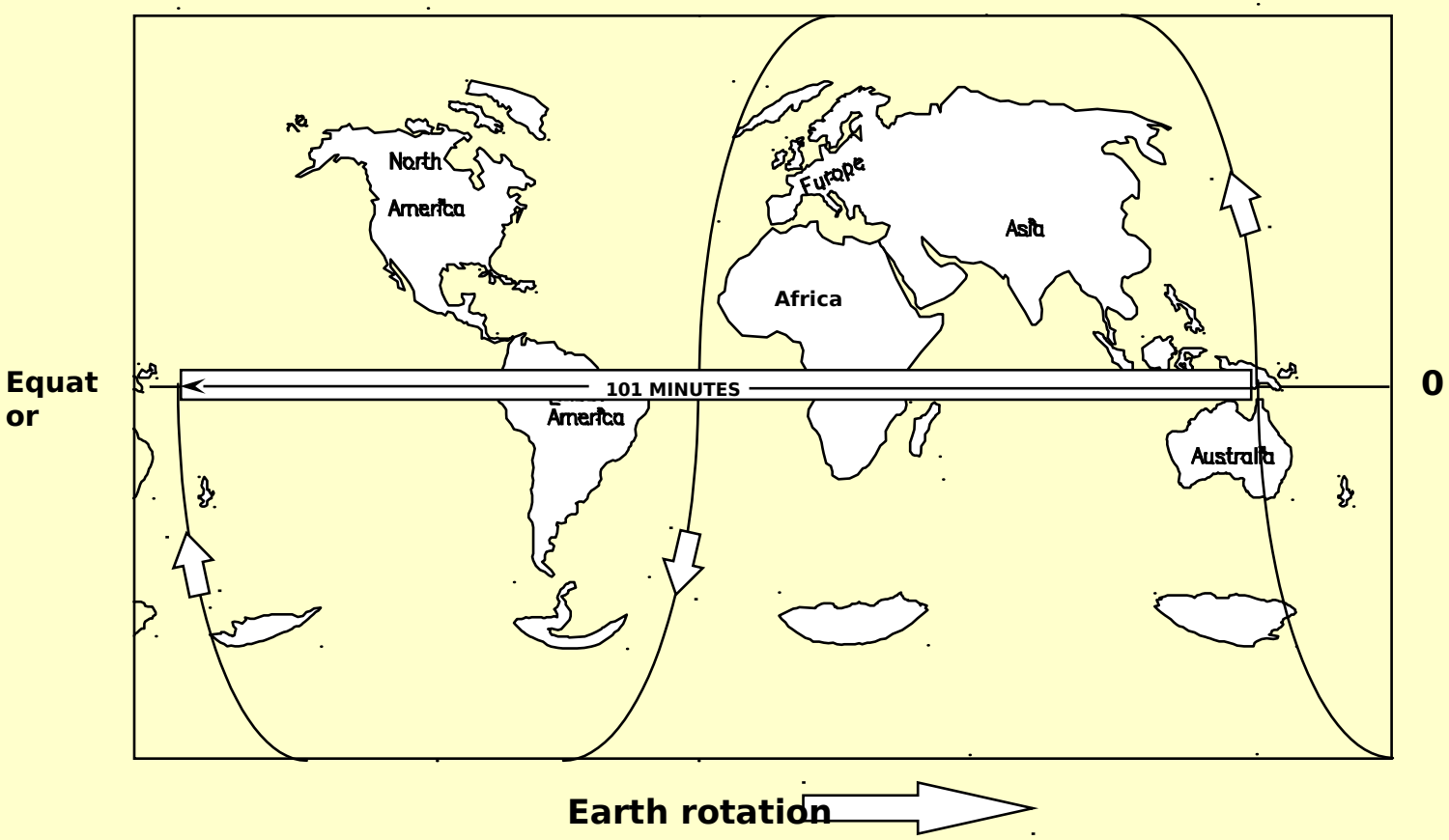
POLAR ORBITAL PARAMETERS (pt 2 of 2)



From a spatial view, the satellite orbit may be broken down into four quadrants.

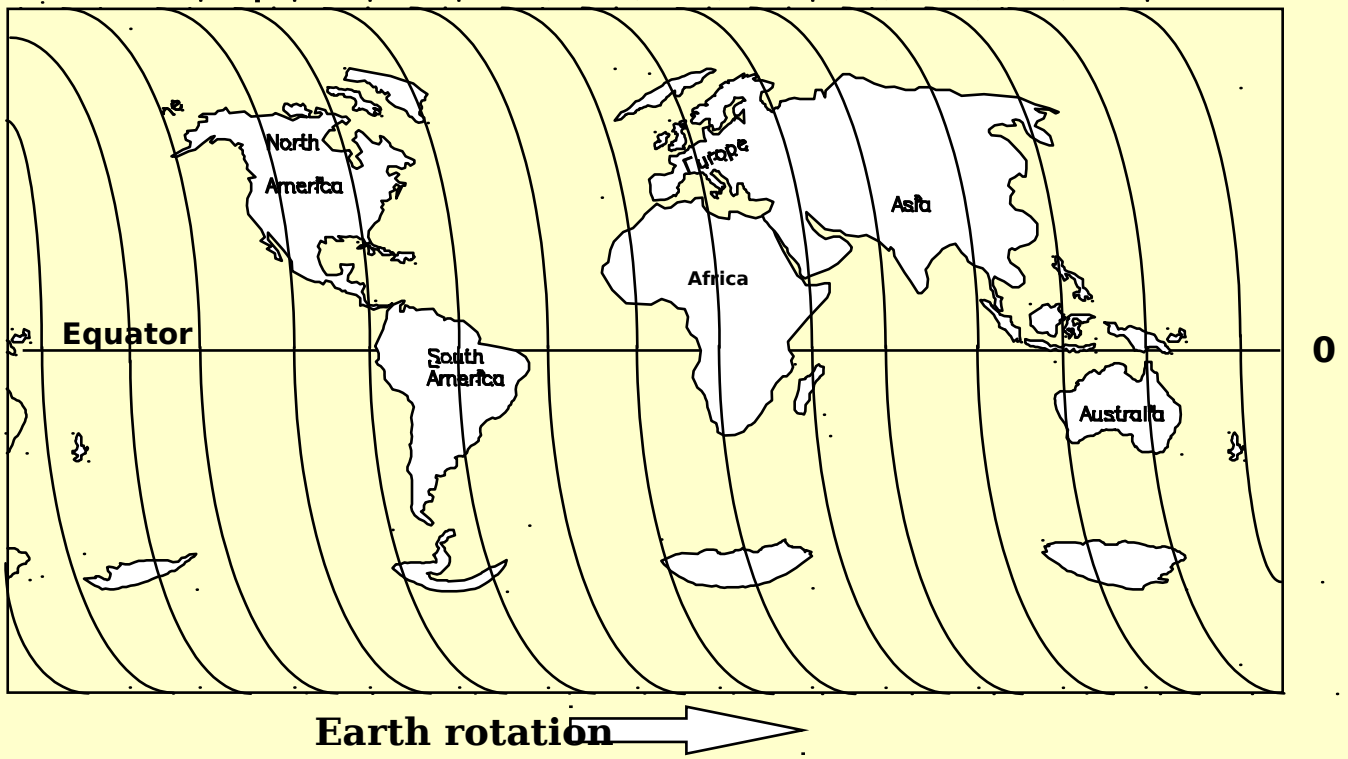
SATELLITE ORBIT

- Polar satellites orbit the earth approximately once every 101 minutes.



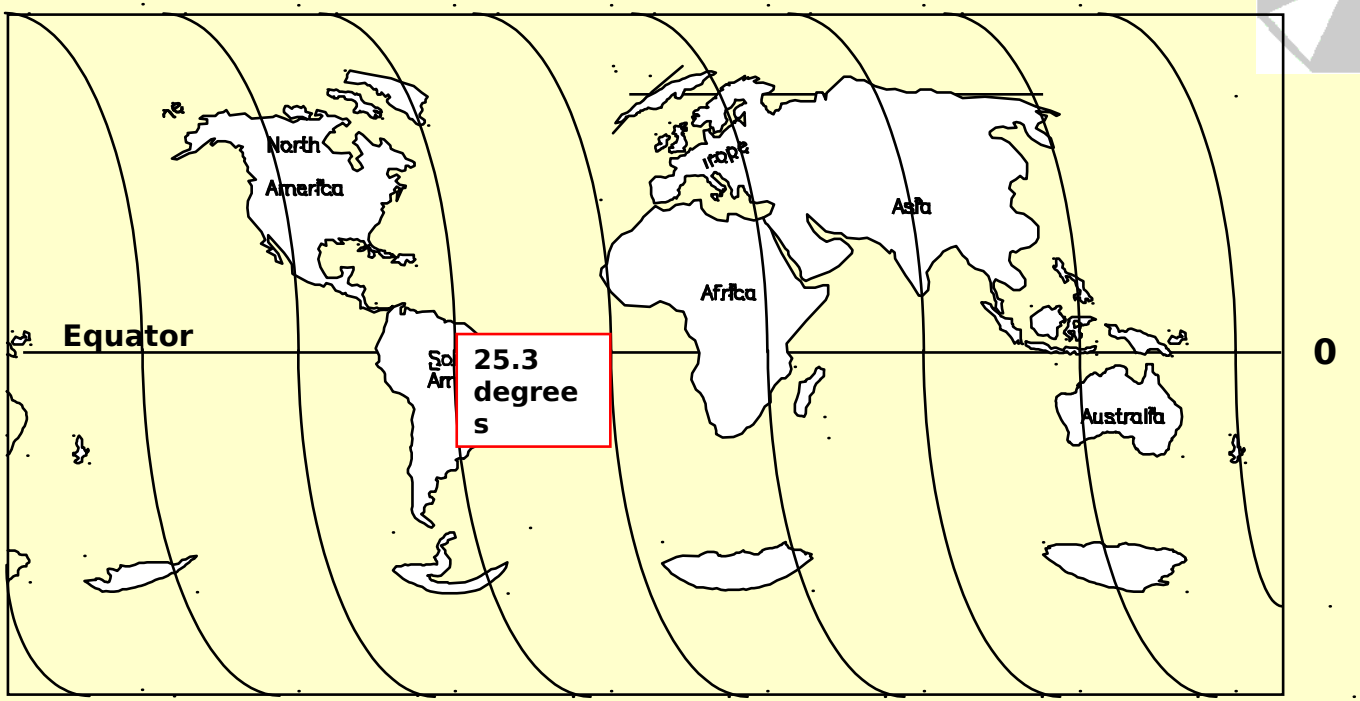
DAILY ORBITAL SUB-TRACK

- Single Polar Spacecraft



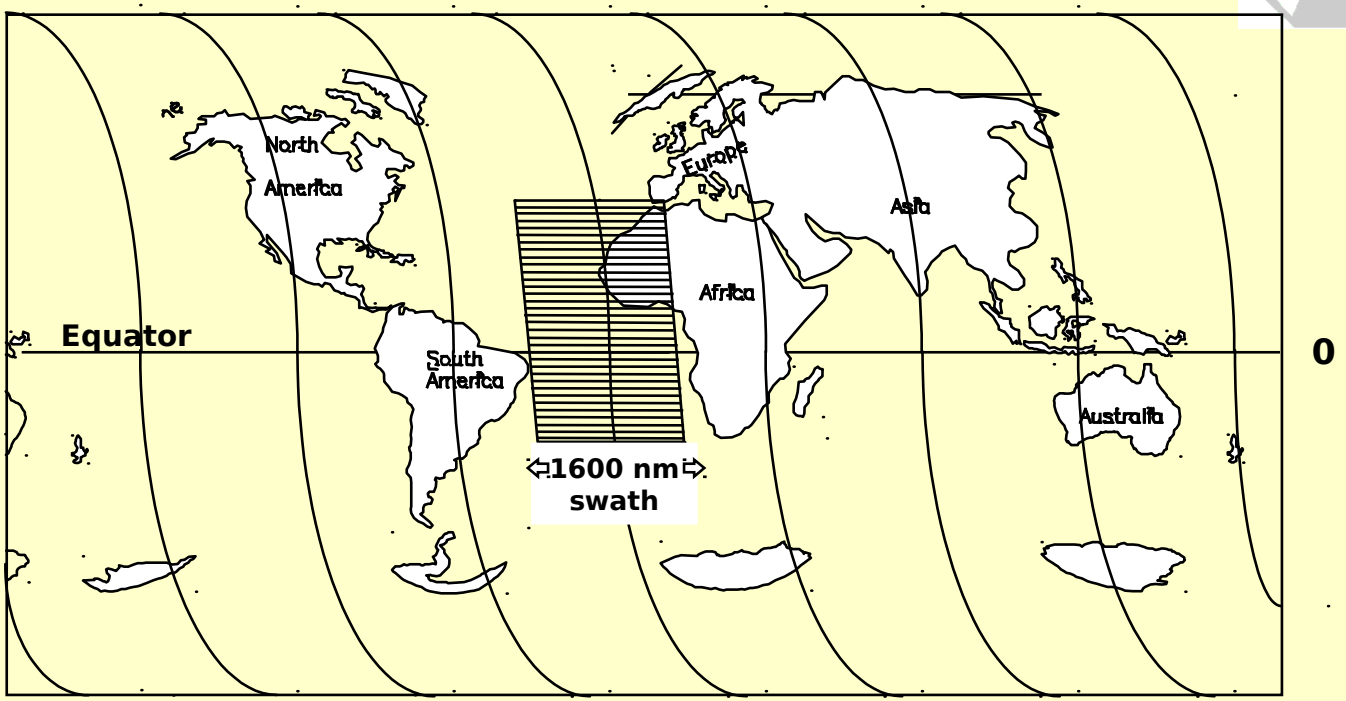
Dividing 101 minutes into 24 hours, one can see that the satellite has about 14 rev
(revs or passes) per day. Meanwhile, the earth is rotating from West to East. The
allows a full mapping of the earth twice every 24 hours.

WORLD GRAPHIC



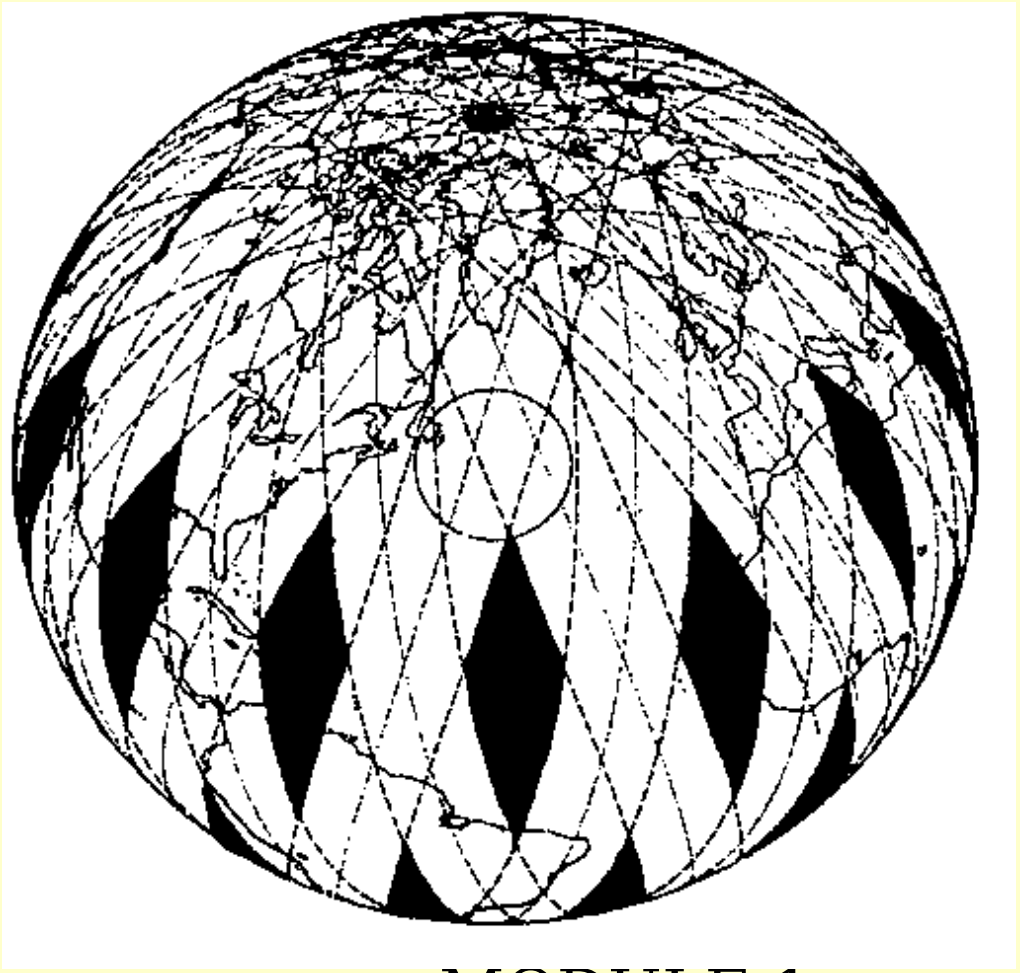
Each pass is separated by approximately 25.3 degrees. This is due to the Earth's rotation and the time that it takes the satellite to orbit the Earth. 25.3 degrees at the equator is equal to 1600 nautical miles.

WORLD GRAPHIC WITH SCAN LINES



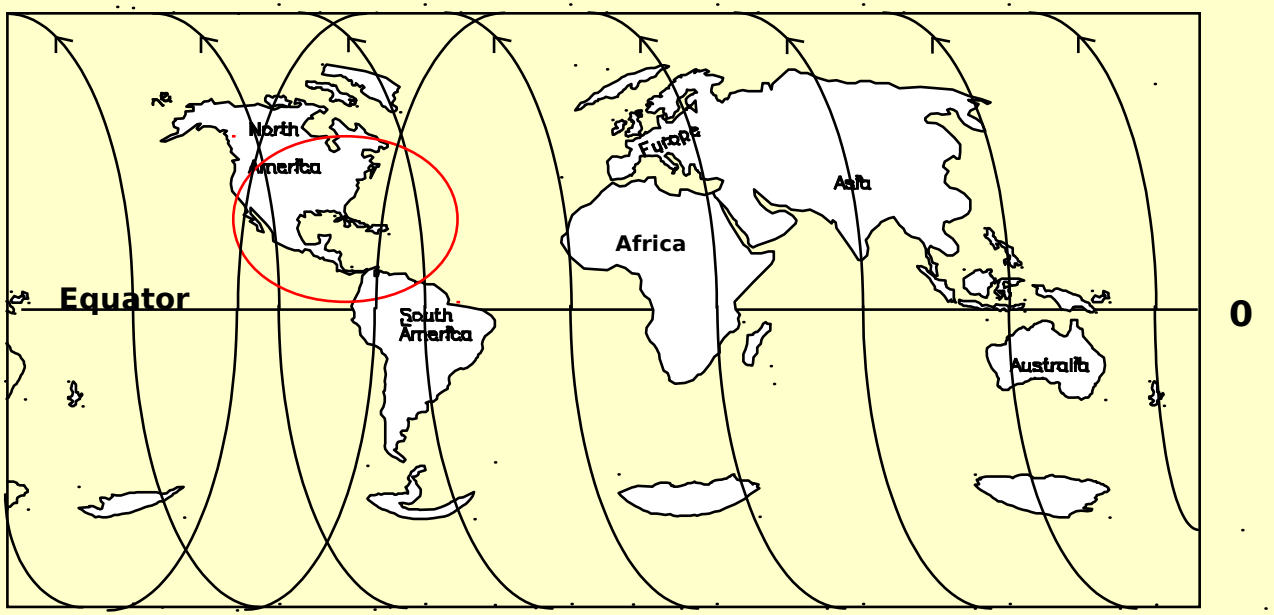
Each scan line is approx 1600 nm miles long. There is increasing overlap as the satellite travels closer to the pole. The scanner is always on unless it has failed or intentionally turned off.

POLAR ORBITER SUBTRACKS (24HR PERIOD)



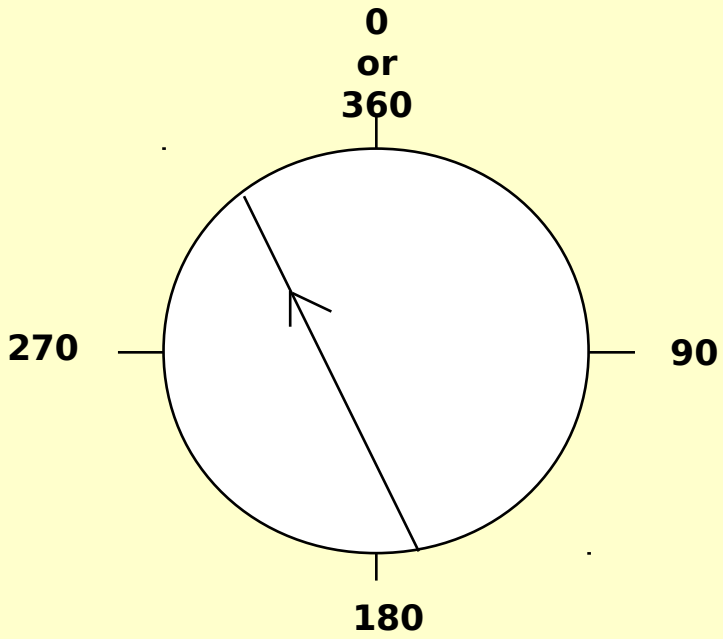
STT SITE STATION CIRCLE

- Your site station circle is a representation of your antenna's field of view for orbiting satellites. A site in Melbourne, FL, is shown below. The site will see two ascending and two descending passes from the satellite in the illustration.



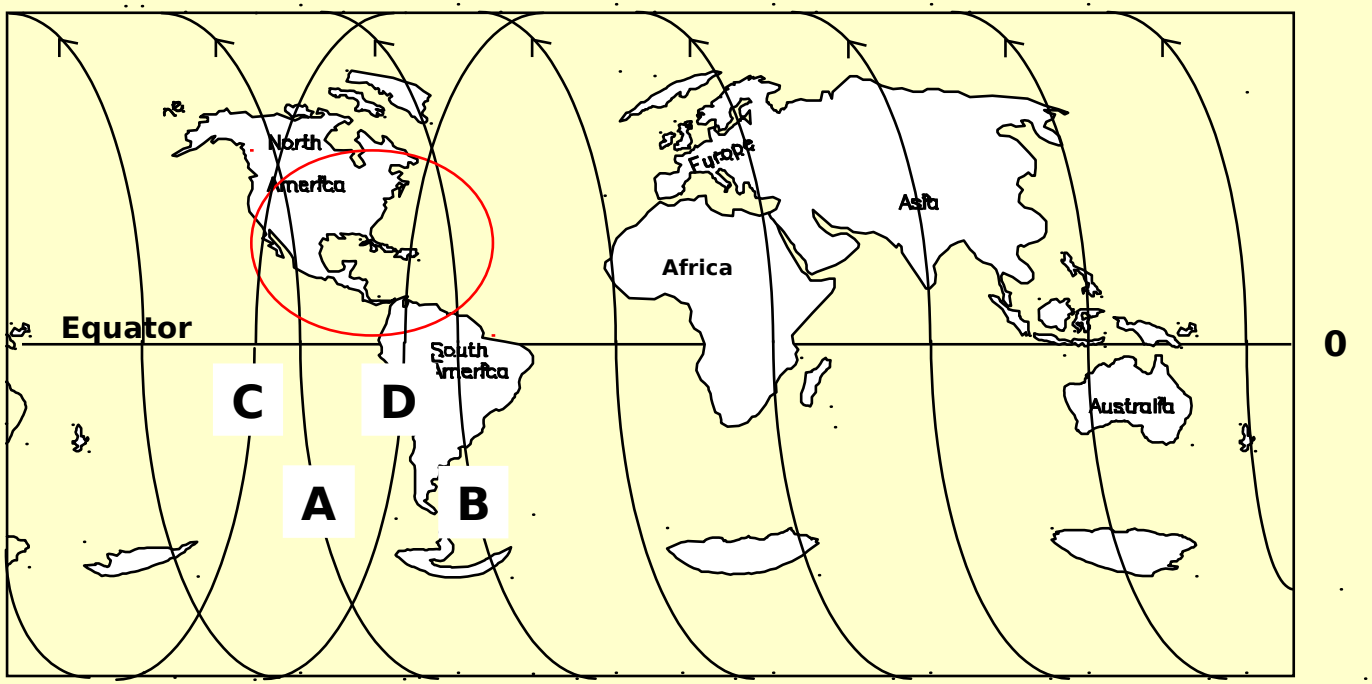
STATION CIRCLE SHOWING POLAR SATELLITE PASS

- For a polar satellite pass, you may take the same quadrants and plot the antenna path for any given pass.
  - EXAMPLE: If the pass rises at 170 degrees and fades at 310, it would look like the path shown below.

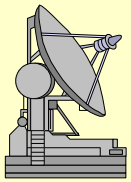


ANTENNA LOOK ANGLES

- Using the station circle for the antenna at the Melbourne site, what are the antenna's look angles for the four passes?



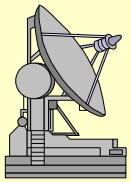
Of the four passes, which are ascending and which are descending?



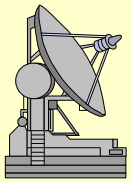
POLAR-ORBITING PAIRS

- Ideally, DMSP polar-orbiters operate as a pair.
- One morning bird and one noon bird.
  - They “see” every location of the planet at least twice a day at about the same local time.
  - STT receives real time data feed
- The morning bird gathers data along the terminator. This is the earliest available data and can be collected down to a quarter-moon lit scene.
- With this sensitivity, the DMSP can provide nighttime visual pictures during the period before and after the full moon.

POLAR ORBITER PROS AND CONS

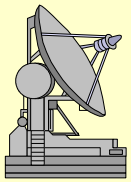


- **Pros**
  - Better resolution than geostationary satellites due to lower orbit.
  - Better coverage and resolution nearer the poles than geostationary satellites.
  - Global Data available for military needs.
- **Cons**
  - Each satellite over your location as little as once every 12 hours.
  - Multiple satellites may pass over your location simultaneously, causing scheduling conflicts.



DMSP DATA/SPECIAL SENSORS (pt 1 of 2)

- DMSP sensors provide direct readout imagery to the STT. These sensors include:
  - Operational Linescan System (OLS), the primary sensor. Provides visible and infrared data in a scan area that covers a 1600 nm swath.

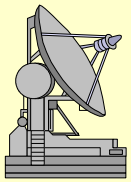


DMSP DATA/SPECIAL SENSORS (pt 2 of 2)

- Special Sensor Microwave Imager (SSM/I) - Measures the microwave radiation from the earth's atmosphere and surface. Its main advantage is that it is fairly insensitive to cloud cover. The SSM/I swath is 800 nm, 1/2 the width of the OLS.

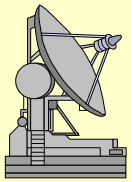
- Special Sensor Microwave Temperature Sounder (SSM/T-1) - Used to derive vertical temperature, height, and pressure profiles of the atmosphere.

- Special Sensor Microwave Water Vapor Profiler (SSM/T-2) - Used to derive vertical water vapor profiles of the atmosphere.



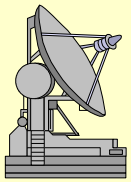
NOAA POLAR-ORBITERS (pt 1 of 2)

- NOAA satellites use an Advanced Very High Resolution Radiometer (AVHRR) to remotely determine cloud cover and surface temperatures.
- AVHRR - 5-channel scanning radiometer. This instrument uses visible and infrared detectors to observe vegetation, clouds, lakes, shorelines, snow, and ice.
  - » Channel 1= Visible
  - » Channel 2 = Visible + Near Infrared
  - » Channel 3 = Middle Infrared
  - » Channel 4 = Far Infrared
  - » Channel 5 = Far, Far Infrared



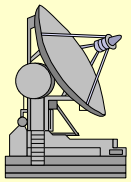
NOAA POLAR-ORBITERS (pt 2 of 2)

- NOAA satellites provide two types of data streams:
  - APT - Automatic Picture Transmission. Direct, real time analog transmission containing data from 2 of the 5 AVHRR spectral channels, visible and infrared, at 2.1 nm resolution.
    - » Daytime Channels 2 & 4
    - » Nighttime Channels 3 & 4
  - HRPT - High Resolution Picture Transmission. Direct, real time digital images containing data from all 5 AVHRR spectral channels, visible and infrared, at .6 nm resolution.



OTHER POLAR SATELLITES

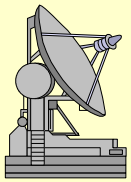
- **METEOR**
  - Russian
  - Not totally reliable
- **FENG YUN**
  - Chinese
  - Hit-or-miss

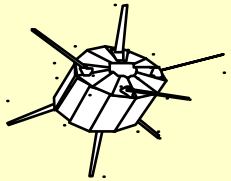


SATELLITE TO DATA STREAM CORRELATION (pt 1 of 2)

- **NOAA**
  - HRPT via 3 or 4.6 ft Tracking Antenna
  - APT via APT Antenna
- **DMSP**
  - RDS via 2, 3 or 4.6 ft Tracking Antenna
  - RTD via 3 or 4.6 ft Tracking Antenna
- **GOES/METEOSAT/GMS**
  - WEFAX via WEFAX Antenna
- **GPS**
  - Time/Position data via GPS Antenna

SATELLITE TO DATA STREAM CORRELATION

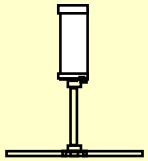




NOAA, Feng-Yung and Meteor

APT Data

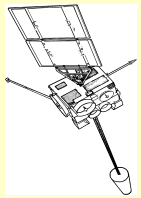
APT Antenna



GPS

Time/Position Data

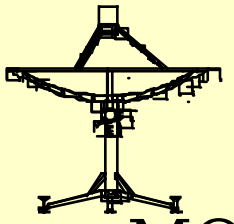
GPS Antenna

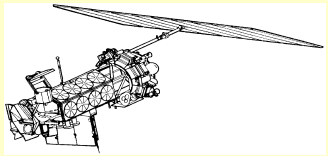


GOES, Meteosat and GMS

WEFAX Data

WEFAX Antenna



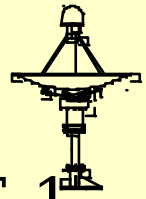


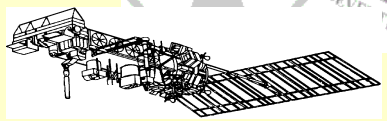
DMSP

RDS

RDS/RTD

2 ft Tracking Antenna

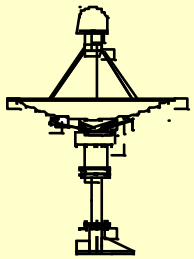


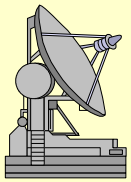


NOAA

HRPT Data

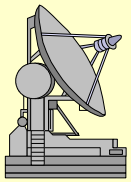
3 or 4.6 ft Tracking Antenna





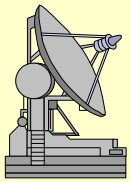
LESSON 1.1 REVIEW

- This lesson topic covered:
  - Environmental Satellite Facts
  - Geostationary Satellites
  - Polar Satellites
    - » DMSP Satellites
    - » NOAA Satellites
    - » Other Satellites
  - Satellite to data stream correlation
- Questions



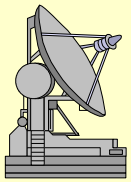
LESSON 1.2

STT
SYSTEM INTRODUCTION



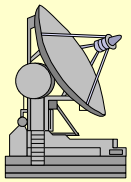
LESSON 1.2 OVERVIEW

- This lesson topic will cover STT:
  - Mission
  - Configuration
  - Specifications
  - Functional Description
  - Equipment Groups



LESSON 1.2 OBJECTIVES

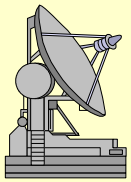
- Using the AN/TMQ-43 and system manuals, class notes, student will be able to demonstrate knowledge of:
  - Basic, Enhanced and Lightweight configurations of the STT and the data types that each can receive.
  - Data reception and processing functionality of the STT.
  - Data flow of the STT.
  - Four equipment groups of the STT.



STT MISSIONS

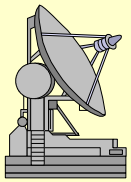
- Wartime/Contingency Mission
  - The AN/TMQ-43 Weather Terminal Set system provides tactical users, deployed worldwide, with a first-in source of meteorological satellite data in forward areas of conflict.

- Peacetime Mission
  - The AN/TMQ-43 system provides daily meteorological satellite information to tactical forces as a planned addition to the Defense Meteorological Satellite Program (DMSP) user community. The AN/TMQ-43 portable weather terminals provide an interactive meteorological satellite data analysis capability without reliance on surface communications.



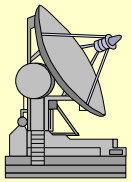
CONFIGURATIONS/CAPABILITIES

- For our purposes the AN/TMQ-43 has two configurations:
  - **Basic:** will automatically receive:
    - » DMSP Real Time Data Smooth **(RDS)** data stream with 1.5 nm resolution.
    - » Automatic Picture Transmission **(APT)** imagery with 2.1nm resolution.
    - » Weather Facsimile **(WEFAX)** data.
  - **Enhanced/Lightweight:** same capability of Basic plus:
    - » DMSP Real Time Data **(RTD)** data stream with .3 nm resolution.
    - » NOAA High Resolution Picture Transmission **(HRPT)** data stream with .6 nm resolution.



SPECIFICATIONS (pt 1 of 2)

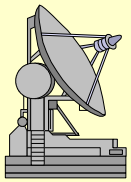
- Assembly/Disassembly
  - Basic STT - 2 person team in 45 minutes.
  - Enhanced/**L- STT** - 2 person team in 60 minutes.
  - Both systems can be disassembled and packed with a 2 person team wearing chemical biological warfare ensemble (CBWE) including gloves.
- Power
  - The STT accepts power from:
    - (1) Commercial AC power - U.S. and foreign - 120/240 VAC 60/50Hz.
    - (2) Vehicle's power system - 24 VDC.
    - (3) AC Generator.
- Environmental Conditions
  - The STT operates and can be stored in all environmental climates including arctic, desert, temperate, and tropical.



SPECIFICATIONS (pt 2 of 2)

- The processing, display, printing, and data storage equipment are operable in a tent, crude shelter, or military vehicle that accompanies a deployed unit.

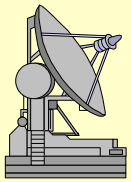
- Packaging
  - The AN/TMQ-43 is packaged in containers that require no more then two people to lift and carry.
    - » Basic STT - contained in 8 transit cases.
    - » Enhanced STT - 8 basic + 4 additional cases.
    - » **Lightweight STT - 9 transit cases.**
- Transport
  - The AN/TMQ-43 is transportable on a High Mobility Multi-Wheeled Vehicle (HMMWV) for surface transportation or a 463L pallet for air transportation; 1/4 pallet for Basic and 1/2 pallet for Enhanced/L-STT.



DATA RECEPTION AND PROCESSING (pt 1 of 2)

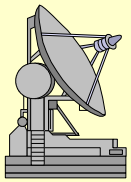
- The AN/TMQ-43 is capable of receiving and processing the following data:
  - Ingests, processes, and displays encrypted data from the DMSP polar orbiting satellites including:
    - (1) OLS Operational Linescan System
    - (2) SSM/I Special Sensor, Microwave/Imager
    - (3) SSM/T1 Special Sensor, Microwave/Temperature Sounder
    - (4) SSM/T2 Special Sensor, Microwave/Water Vapor Sounder
  - Generates Environmental Data Records (EDRs) from the Sensor Data Records (SDRs) and Visual/Infrared imagery.
  - Ingests, processes, and displays APT data from NOAA, Russian, and Chinese polar orbiting satellites.

DATA RECEPTION AND PROCESSING



(pt 2 of 2)

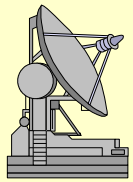
- Ingests, processes, and displays WEFAX data from various Geostationary meteorological satellites:
  - (1) GOES.
  - (2) European METEOSAT.
  - (3) Japanese Geostationary Meteorological Satellite (GMS).
- Ingests, processes, and displays High Resolution Picture Transmission (HRPT) data from the NOAA polar orbiting satellites.
- Receives up to three streams of meteorological satellite data simultaneously.
- Displays satellite imagery while it is being received.



EXTERNAL SYSTEMS

- The AN/TMQ-43 is capable of transmitting images and products to other systems and formats including:
  - (1) TAWDS - Transportable Automated Weather Distribution System
  - (2) CWS - (aka TFS)
  - (3) IMETS - Integrated Meteorological System
  - (4) SIDS - Satellite Imagery Dissemination System

L-STT SYSTEM BLOCK DIAGRAM



MET & GPS SATELLITES

COMSEC EQUIPMENT

KG-144 (RTD)

MYK-7A (RDS)

DTD

APT

WEFAX

DMSP

HRPT

GPS

RF/ANTENNA EQUIPMENT

DAS

P-BAY

WK-STN

SOFTWARE

PROCESSING EQUIPMENT

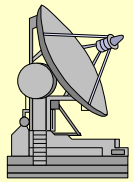
TO: LCD PANEL

TO: PRINTER

TO: EXTERNAL USERS VIA LAN OR PC CONNECTIVITY

AUXILIARY EQUIPMENT

STT SYSTEM BLOCK DIAGRAM



MET & GPS SATELLITES

COMSEC EQUIPMENT

KG-144 (RTD)

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DMSP

HRPT

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RF/ANTENNA EQUIPMENT

DAS

WK-STN

SOFTWARE

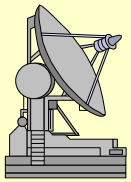
PROCESSING EQUIPMENT

TO: MONITOR

TO: PRINTER

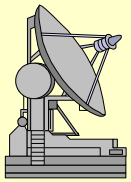
TO: EXTERNAL USERS VIA LAN OR PC CONNECTIVITY

AUXILIARY EQUIPMENT



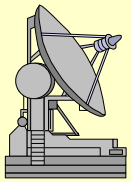
STT EQUIPMENT GROUPS

- RF/Antenna Equipment Group
- Processing Equipment Group
- COMSEC Equipment Group
- Auxiliary Equipment Group



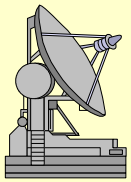
RF/ANTENNA GROUP

- 3 or 4.6 Ft Tracking Antenna
- 2 Ft Tracking Antenna (Basic Only)
- APT Antenna
- WEFAX Antenna
- GPS Antenna



PROCESSING EQUIPMENT GROUP

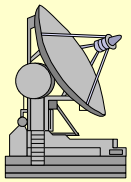
- Data Acquisition Subsystem (DAS)
- Peripheral Bay (L-STT Only)
- Workstation
- LCD Panel or Monitor
- External Keyboard/Mouse



COMSEC GROUP

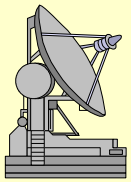
- MYK-7A
- KG-144
- Data Transfer Devices (DTDs) 2 ea
- KOI-18 and fill cable

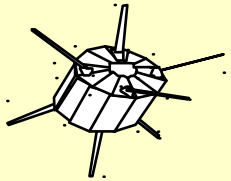
AUXILIARY EQUIPMENT GROUP



- Printer
- Signal Monitor
- AC Power Distribution Assembly (PDA)
- Power Inverter
- Cables
- Cases

SATELLITE TO DATA STREAM CORRELATION

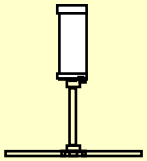




NOAA, Feng-Yung and Meteor

APT Data

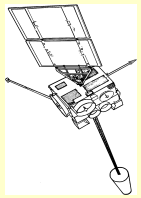
APT Antenna



GPS

Time/Position Data

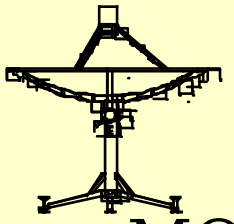
GPS Antenna

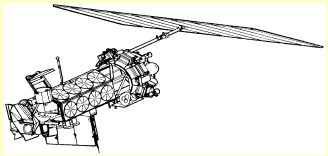


GOES, Meteosat and GMS

WEFAX Data

WEFAX Antenna



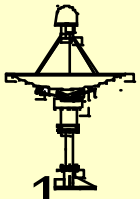


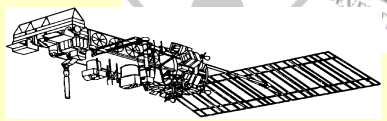
DMSP

RDS

RDS/RTD

2 ft Tracking Antenna

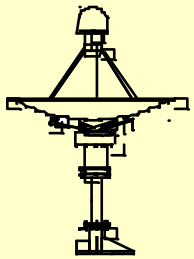


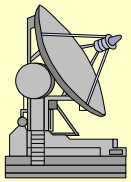


NOAA

HRPT Data

3 or 4.6 ft Tracking Antenna





LESSON 1.2 REVIEW

- This lesson topic covered the STT:
  - Mission
  - Configuration
  - Specifications
  - Functional Description
  - Equipment Groups
- Questions